



Some popular output triodes — 1

A special group of valves has always been held in high regard by high quality audio enthusiasts. These are the big output triodes, some of which are still in production. This month we look at the first generation of these valves.

Before 1923 and the advent of broadcasting, the concept of fidelity of audio reproduction hardly existed. Headphones were in universal use, and they were judged mainly by their sensitivity. Transmissions were practically all in Morse code, and the prime requirement was audibility. Often receiver audio transformers were tuned to around 1kHz, to improve intelligibility of telegraph signals. In 1920, the only service where audio quality had any meaning was not in radio, but the rapidly expanding telephone repeater technology.

America's Western Electric Bell Laboratories had taken Lee de Forest's erratic Audion triode and by 1915 had tamed it, to become a practical commercial device capable of factory production to close standards. In Europe valve development was accelerated by wartime demands, one very significant result being the famous 'R' valve.

The advent of broadcasting soon created a demand for loudspeakers and, to drive them, valves capable of more than the few milliwatts required by headphones. In Britain, Marconi-Osram had developed from the R valve their type 25, a large valve used by the British Post Office for telephone service. From the type 25, Marconi-Osram produced a family of large triodes, their 'LS' series for loudspeaker work. The LS5A, introduced in 1924, was used by the newly established BBC and became popular with affluent amateurs interested in improving sound quality.

Meanwhile Western Electric had taken one of their wartime valves, the VT2 and in 1917 further refined it to become the 205A, a 'miniature' transmitting valve, capable of handling 300 anode volts. The 205 series underwent several developments, and by 1924 the 205D was in full production.

Western Electric with its research organisation, the Bell Telephone Labora-

tories, was and still is a remarkable organisation. Their prime purpose was to provide the vast Bell Telephone network with its equipment. As well, they are involved in outside commercial undertakings. In Britain and Australasia, they are represented by their affiliates Standard Telephones and Cables (now Alcatel Australia), an organisation I imagine with which most readers are familiar.

Reliability paramount

Not being concerned so much with high volume, low initial cost equipment as with extreme reliability, Western Electric's philosophy for valves has always been very different from the domestic consumer market.

To put this into perspective, in 1978 it

was estimated that replacement of a valve in a submarine repeater could cost \$40,000. Obviously, low initial cost was not significant if it compromised quality and reliability!

It is on record that every one of the 306 Western Electric type 175HQ valves used for the first trans-Atlantic telephone cable operated continuously for 22 years, without a single failure. The later type 455A-F valves were equally reliable. By 1978 there were 5674 of these valves in use, each with an average continuous service of nearly 15 years. There had been only two probable failures and in any event, redundancy of amplifier design meant that service was not affected. Even premium semiconductors would find it hard to beat that sort of record.

This then is the background to the type of organisation that in 1924 produced the 205D. I guess that few readers have handled a 205D, but as we shall see, many will have encountered the 205D in operation.

Favoured by hams

Meanwhile, American General Electric and Westinghouse were developing valves and equipment for RCA. As we related in this column for May 1990, the production of the first practical moving coil loudspeaker depended on the availability of an audio amplifier capable of producing a genuine one watt. This became possible when, in 1924, RCA's UV210, essentially a scaled up UV201A valve, became available. The following year it received the new long-pin base, to become the UX210 and proved to be popular for audio amplifiers and especially with radio amateurs as an oscillator and RF amplifier.

Transmitting versions, the 10Y and 801 were produced. Only with the advent of the equally ubiquitous 807, immediately prior to World War II was the UX210 superseded.

At this stage I would remind readers

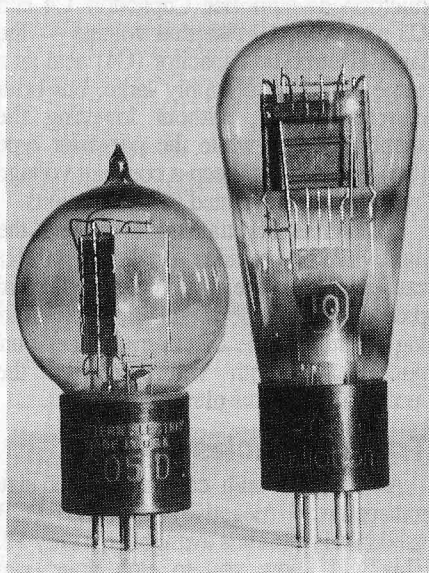
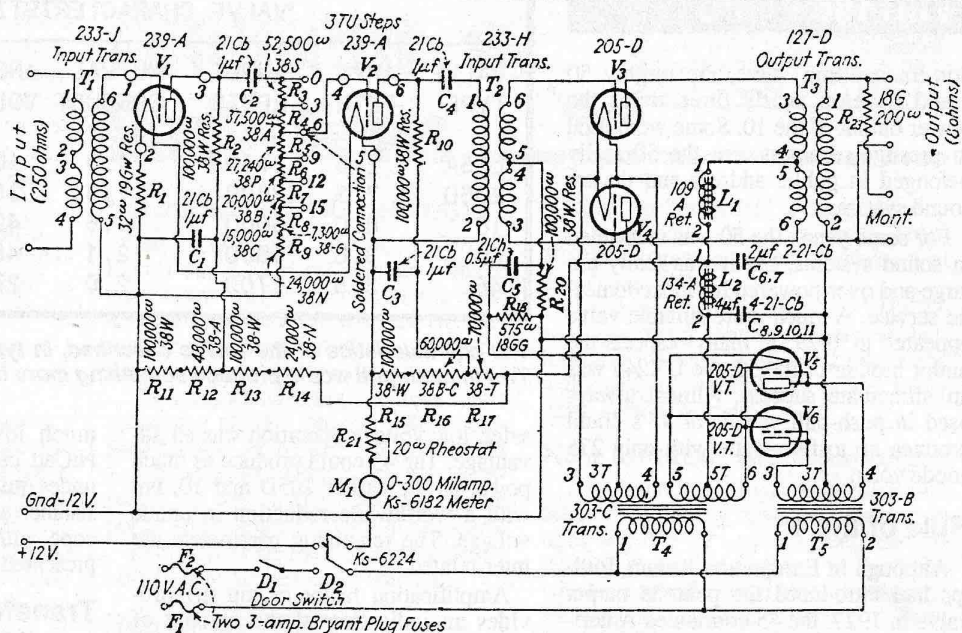


Fig.1: Although the spherical Western Electric 205S and the S-bulb RCA UX210 were very different in construction, their characteristics were comparable. Globular envelopes were a distinctive feature of many WE valves, which had oxide-coated filaments or cathodes.

State of the art audio in the late 1920's: Western Electric 46A amplifiers using 205D triodes as rectifiers, as well as out-pump valves, were used in thousands of cinemas for early 'talkie' sound installations. As WE had not developed an indirectly heated valve, low microphony type 239A and later the 264 series with 1.5V/300mA filaments were used for the voltage amplifiers. The 46A could produce only about four watts, but this was adequate for horn-loaded speaker drivers such as the WE555.



that the original RCA numbering system for valves was clumsy. The prefix UV, UX and UY referred to the base, and the first digit identified the supplier — 1 for Arcturus, 2 for RCA and 3 for Cunningham etc. Only the second and third digits had any real significance, and before long the rest was dropped. Thus the UX210 was known as the 10, the UX250 as the 50 and the UX245 became the 45. This abbreviation did not apply to Western Electric valves, which generally had their own system of identification.

Two major developments influenced high quality sound research in the mid 1920's. These were electrical gramophone recording and sound movies, both of which set new standards in reproduction and sound generation. Both the Western Electric and RCA organisations were major players, and good use was made of both the 205D and the 210.

50 years of service

Western Electric designed new amplifiers, including the 42A and 46A, for the 'talkies'. Both used a push-pull pair of 205D valves in the final stage, and were capable of producing three to four watts of audio power. Used with WE 555 horn-loaded speaker drivers, this was sufficient power for small movie theatres. But for larger auditoriums, additional power was provided by the type 43A amplifier, which used a push-pull pair of 211 transmitting valves coasting at a modest 12 watts output!

Many thousands of the 42A and 46A amplifiers were in use world wide, and such was the quality of their design

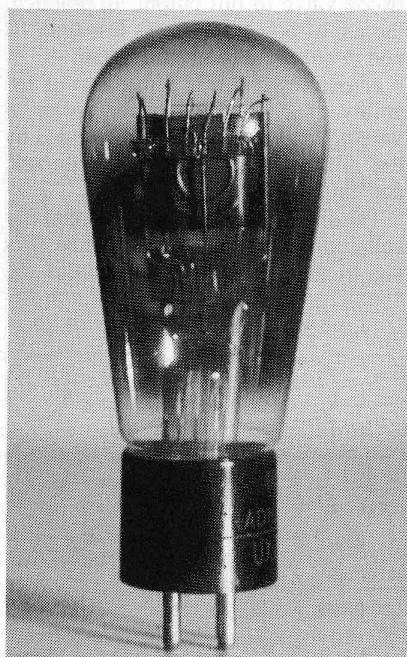


Fig 2: For the best part of three years, the UX245 practically monopolised American receiver output stages.

and construction that some were still in service in the early 1980's! There can be few other types of electronic equipment with continuous service spanning more than half a century, and there must be few readers who have not at some time attended a WE-equipped theatre and heard one of these amplifiers in operation.

By 1928, moving coil speakers were

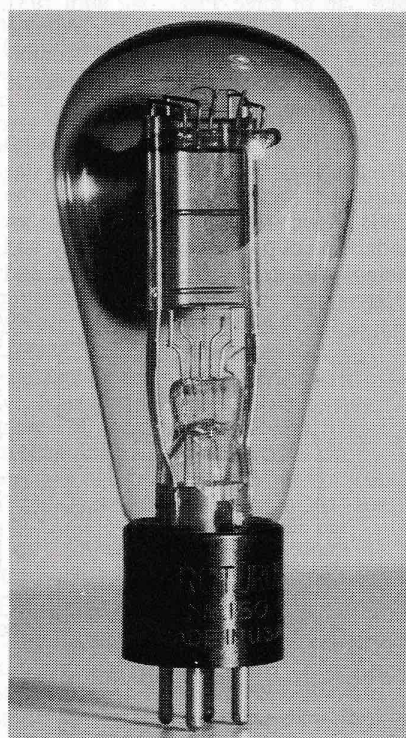


Fig.3: With the largest bulb ever used for American non-transmitting valves, the impressive UX250 was used in some 'top of the line' receivers.

beginning to be widely used, in many cases installed in console cabinets with their improved baffling. More audio power could be used, and in February RCA announced the Westinghouse developed UX250. With the biggest envelope ever used on an American

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non-transmitting valve, the mighty 50 could develop nearly three times the power output of the 10. Some were used in prestige receivers, but the 50 really belonged in public address and theatre sound systems.

For some years, the 50 was unrivalled in sound systems, but it was really too large and over-powered for most domestic service. A much more suitable valve appeared in 1929. In many respects the junior brother of the 50, the UX245 was an immediate success. Almost always used in push-pull, a pair of 45's could produce up to five watts with only 275 anode volts.

Rule of the 45

Although in Europe and Britain, Philips had introduced the pentode output valve in 1927, the 45 dominated American receiver output stage design for the best part of three years. Not until 1931 did America have a really acceptable output pentode. Even then the 45 continued to be used occasionally, in receivers made for the quality conscious.

By the end of the decade, valve design had progressed considerably. Some significant characteristics are listed in the table. Anode voltage and current are an indication of power handling ability, and being less stressful on capacitors and

VALVE CHARACTERISTICS						
VALVE TYPE	AMPL FCTR	ANODE RESIS	MUTUAL CONDUCT	ANODE VOLTS	ANODE mA	POWER WATTS
LS5A	2.5	2750	1.0	400	33	2.6
205D	7.3	3800	1.9	350	30	1.8
10	8.0	5000	1.6	425	18	1.6
50	3.8	1800	2.1	450	55	4.6
45	3.5	1700	2.0	275	35	2.0

The characteristics of the valves described, in typical single-ended operation. Two in push-pull would produce something more than twice the power output.

safer, low voltage operation was an advantage. The 45 could produce as much power as the earlier 205D and 10, but with a worthwhile reduction in anode voltage. The remaining parameters are inter-related.

Amplification factor or mu (μ) provides an indication of the amount of grid signal voltage required to drive a triode valve to full output. In practice, the mu of power triodes is less than 10 and in some cases less than four.

Anode resistance is a measure of the ability of a valve to deliver power to varying loads. This can be illustrated by the differing behaviour of carbon/zinc and NiCad cells.

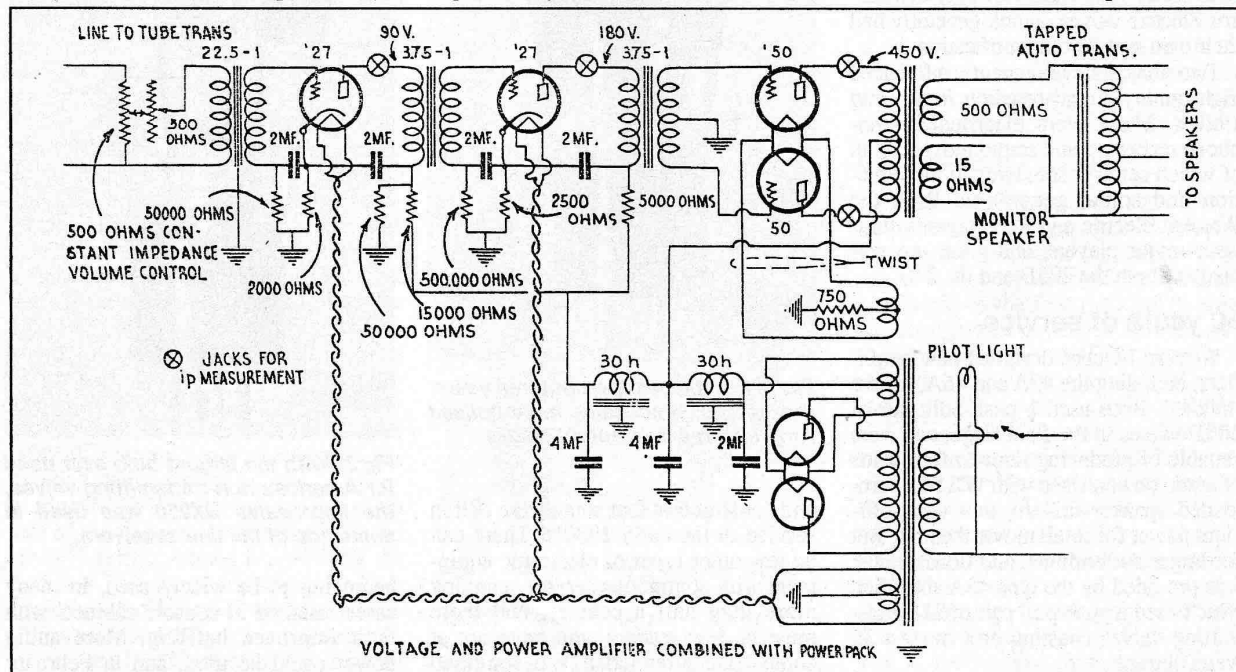
The terminal voltage of a standard dry cell connected to a low resistance falls significantly under load, whereas the

much lower internal resistance of a NiCad cell has little effect on voltage under quite heavy loads. A low plate resistance enables a triode to more readily cope with the extremely variable load presented by a moving coil loudspeaker.

Transformer inductance

Another factor is transformer requirements. For a given low frequency performance, output transformer primary winding inductance requirements are proportional to anode resistance. Referring to the operating conditions given in the table, for the same frequency response, a transformer for a type 10 valve would require 5000/1700 or nearly three times the inductance required for a type 45.

The ideal power triode would therefore have a low anode impedance and a



A typical high powered audio amplifier using a pair of 50's. Transformer coupling was universal, and frequently the limiting factor in reproduction quality. It was commonly thought that grid blocking made R-C coupling of output stages impractical.

high amplification factor; but unfortunately, the two are in conflict. For a given valve geometry, raising the amplification factor increases the anode resistance. The ratio of these two parameters is a constant called, in the American system, the *transconductance* and is measured in micromhos (the same as the modern microsiemens, or μS).

In British terms the same ratio is known as the *mutual conductance* and is expressed in mA/V — the change in anode current, in milliamps, for a change of one grid volt.

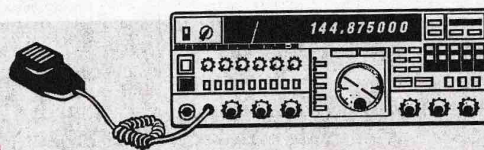
Clearer terminology

In my opinion the British terminology provides a clearer concept. Fortunately, regardless of the system used, the result is the same, but it would have helped if the Americans had chosen millimhos (millisiemens, or mS) for the unit, as then the figures in the two systems would have been identical. As it is, in American terms the 45 has a transconductance of 2000 micromhos, whereas the British would quote the mutual conductance as 2mA/V . Despite the apparent difference the two are identical.

I have written at length about transconductance or mutual conductance, because it is the characteristic that can be regarded as a figure of merit for output valves. In 1929, the limit had been reached at around 2.0mA/V , and only by raising this could the output triode be improved.

How Marconi-Osram advanced valve design, leading to the second generation of output triodes, and prevented their complete eclipsing by the pentode will have to wait until the second of these articles. ♦

Amateur Radio News



US auctions UHF spectrum

The WIA's Bill Roper, VK3ARZ reports that the US government plans to auction two large segments of the radio spectrum between 1.8 and 2.2GHz. The scheme is apparently part of a plan to cut the government's budget deficit.

The auctions have been approved by a committee of the Congress, while companion plans are passing through the US Senate. President Clinton apparently approves of the auctions scheme, which practically guarantees they will be passed.

The auctions are forecast to return some US\$7 billion to the US government.

Report on VK2DIK's balloon contacts

From Al Pearson, VK2CU came a first-hand report of contacts made with Dick Smith VK2DIK on June 17-18, during his recent successful balloon flight from Carnarvon in WA to Tabulam on the east coast. VK2CU was operating HF portable at Angledale, 430km south of Sydney, and at 0845 EAST on June 17 received very strong and clear signals from VK2DIK operating on 14.150MHz. At the time the balloon was at an altitude of 16,000ft and Dick was quite uncomfortable, having had to remove his oxygen mask to speak into the microphone.

VK2CU reports that VK4ABJ and VK6ABS were also being received very well, with the signals from the flight control centre VK2AWI in Terrey Hills, Sydney rather weak at the time. Dick had begun to experience problems with his generator, and only battery power was available. However he made reference to good wishes being received from Phil Kavanaugh, the competing balloonist.

At 1120 EAST signals were heard from VK2DIK reporting flight progress and giving their position as over Mee Katharra, still at an altitude of 16,000ft but preparing to switch on the burner.

Next day at 0952 EAST, VK2DIK was received on 7.070MHz and gave their position as south-east of Broken Hill, at 20,200ft. VK2BRG from Coff's Harbour was heard calling VK2DIK at 1157, while at 1430 VK2DK was heard reporting to VK2AWI that he had a visual sighting of the balloon at Narrabri. Then at 1450 a report of another visual sighting was made by VK2AUK, south-east of Bingara. When the balloon began its descent at 1630 EAST, VK2ATS at Inverell and

VK2WT at Tenterfield were monitoring the frequency, and apparently heard VK2DIK report a perfect touchdown at Tabulam at 1704.

Our thanks for this report to VK2CU, who says that monitoring the historic balloon trip was one of the most interesting and satisfying experiences of his many years in amateur radio.

New amateur radio society

The Australian Naval Amateur Radio Society (ANARS) has been formed to bring together all radio amateurs and interested shortwave listeners in Australia who have a professional naval or maritime background. Honorary secretary Terry Clark VK2ALG reports that it is a national society, fully structured and with administration facilities now in place.

Membership is open to all persons who are either serving in, or are retired from, the Royal Australian Navy, WRANS, Naval Reserves or the Australian Merchant Navy. Membership is also open to those who have served in any foreign navy or merchant navy, and who are now Australian citizens or permanent residents.

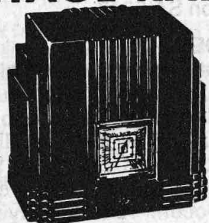
The ANARS was officially launched on August 9 by its headquarters station in Canberra, using its special callsign VI1RAN. This date was chosen because it is the anniversary of the WW2 Battle of Savo Island, in which Australia's heavy cruiser *HMAS Canberra* was sunk. Those interested in joining the ANARS are invited to contact the honorary secretary at 467 McKenzie Street, Lavington 2641 for further details.

Australia tops 35th JOTA participation

With 18.8% of Scouts in the country taking part in the 35th Jamboree of the Air last October, Australia is reported to have scored the highest participation rate among the 32 countries who submitted reports to the World Organisation of the Scout Movement.

The Netherlands were close behind, with 14.2% of their Scouts participating. However, 17.9% of the Guides in the Netherlands took part in last year's JOTA, while 9.9% of Australia's Guides participated. A total of over 400,000 Scouts and Guides from around the world took part. (From the *International JOTA Report for 1992*, supplied to the WIA by Peter Hughes VK6HU) ♦

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